Department of Computer Science & Engineering

Course No : CSE 2106

Course Title : Digital Logic Design Sessional

Experiment No : 06

Experiment Name : a) Design a combinational logic circuit to convert the code Excess-4 to 2 4 2 1 code

b) Design a combinational circuit which will show active segment for 0,1,2,3,5,7,8,9 (decimal)

c) Design a combinational circuit to convert 5-bit BCD to binary equivalent

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Section : A

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Experiment Name: Design a combinational logic circuit which will show the active segment for 0,1,2,3,5,7,8,9 (decimal)

Objective: A seven segment display device is capable to display both alphabets and decimal digit. In this experiment, a combinational circuit is needed to be designed for the decimal digit 0 1 2 3 5 7 8 9. Here don't cares are (4, 6, 10, 11, 12, 13, 14, 15)

Truth Table:

Decimal	Input				Output						
Value	A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	0	1	1	1	1	1	1	0
1	0	0	0	1	0	1	1	0	0	0	0
2	0	0	1	0	1	1	0	1	1	0	1
3	0	0	1	1	1	1	1	1	0	0	1
4	0	1	0	0	X	X	X	X	X	X	X
5	0	1	0	1	1	0	1	1	0	1	1
6	0	1	1	0	X	X	X	X	X	X	X
7	0	1	1	1	1	1	1	0	0	0	0
8	1	0	0	0	1	1	1	1	1	1	1
9	1	0	0	1	1	1	1	1	0	1	1
10	1	0	1	0	X	X	X	X	X	X	X
11	1	0	1	1	X	X	X	X	X	X	X
12	1	1	0	0	X	X	X	X	X	X	X
13	1	1	0	1	X	X	X	X	X	X	X
14	1	1	1	0	X	X	X	X	X	X	X
15	1	1	1	1	X	X	X	X	X	X	X

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For a: $a = \Sigma(0,2,3,5,7,8,9)$ $d = \Sigma(4,6,10,11,12,13,14,15)$

k-map:

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	0	1	1
$\bar{A}B$	X	1	1	X
AB	X	X	X	X
$A\bar{B}$	1	1	X	X

Using k-map, the simplified expression is $a = A + B + C + \bar{D}$

For b: $b = \Sigma(0,1,2,3,7,8,9)$ $d = \Sigma(4,6,10,11,12,13,14,15)$

k-map:

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	1	1	1
$\bar{A}B$	X	0	1	X
AB	X	X	X	X
$A\bar{B}$	1	1	X	X

The simplified expression is, $b = \bar{B} + C$

For c: $c = \Sigma(0,1,3,5,7,8,9)$ $d = \Sigma(4,6,10,11,12,13,14,15)$

k-map:

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	1	1	0
$\bar{A}B$	X	1	1	X
AB	X	X	X	X
$A\bar{B}$	1	1	X	X

The simplified expression is, $c = \bar{C} + D$

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For d: $d = \Sigma(0,2,3,5,8,9)$ $D = \Sigma(4,6,10,11,12,13,14,15)$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	0	1	1
$\bar{A}B$	X	1	0	X
AB	X	X	X	X
$A\bar{B}$	1	1	X	X

The simplified expression is, $d = A + \bar{D} + B\bar{C} + \bar{B}C = A + \bar{D} + (B \oplus C)$

For e: $e = \Sigma(0,2,8)$ $D = \Sigma(4,6,10,11,12,13,14,15)$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	0	0	1
$\bar{A}B$	X	0	0	X
AB	X	X	X	X
$A\bar{B}$	1	0	X	X

The simplified expression is, $e = \bar{D}$

For f: $f = \Sigma(0,5,8,9)$ $D = \Sigma(4,6,10,11,12,13,14,15)$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	0	0	0
$\bar{A}B$	X	1	0	X
AB	X	X	X	X
$A\bar{B}$	1	1	X	X

The simplified expression is, $f = A + B\bar{C} + \bar{C}\bar{D} = A + \bar{C}(B + \bar{D})$

[Distribution Law]

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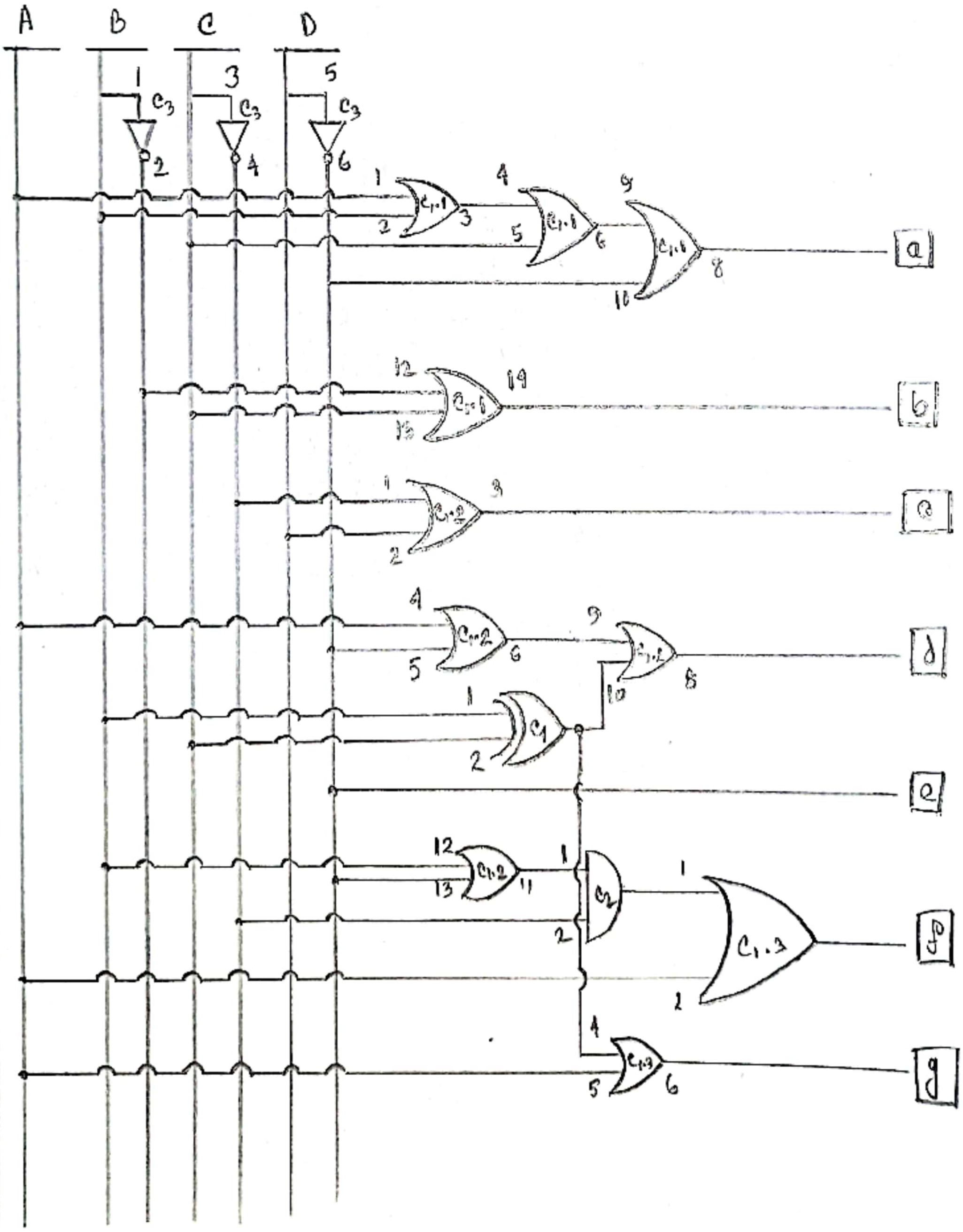
For g: $g = \Sigma(2,3,5,8,9)$ $\quad D = \Sigma(4,6,10,11,13,12,14,15)$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	0	1	1
$\bar{A}B$	X	1	0	X
AB	X	X	X	X
$A\bar{B}$	1	1	X	X

The simplified expression $g = A + \bar{B}C + B\bar{C} = A + (B \oplus C)$

Circuit Diagram:



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IC Requirements:

1. $C_1 \rightarrow$ 74LS32 (OR Gate) - 3 pieces
2. $C_2 \rightarrow$ 74LS08 (AND Gate) - 1 piece
3. $C_3 \rightarrow$ 74LS04 (NOT Gate) - 1 piece
4. $C_4 \rightarrow$ 74LS86 (X-OR Gate) - 1 piece

Conclusion: In this experiment, we have created a seven segment display device. We also designed a combinational circuit which shows the active segments for 0,1,2,3,5,7,8,9. With k-map we have got the simplified expression and circuit diagrams are drawn accordingly.

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Experiment Name: Design a combinational logic circuit to convert the code Excess-4 to 2,4,2,1 code

Objective: 2,4,2,1 code is a complementary binary-coded decimal (BCD) code. Excess-4 codes are unweighted codes which are obtained by adding 4 to each decimal digit. In this experiment we are going to convert Excess-4 to 2421 code. Using k-map, we will get the simplified expression.

Truth Table:

Decimal	Input				Output (2,4,2,1 code)			
Value	A	B	C	D	w	x	y	z
0	0	0	0	0	X	X	X	X
1	0	0	0	1	X	X	X	X
2	0	0	1	0	X	X	X	X
3	0	0	1	1	X	X	X	X
4	0	1	0	0	0	0	0	0
5	0	1	0	1	0	0	0	1
6	0	1	1	0	0	0	1	0
7	0	1	1	1	0	0	1	1
8	1	0	0	0	0	1	0	0
9	1	0	0	1	0	1	0	1
10	1	0	1	0	0	1	1	0
11	1	0	1	1	0	1	1	1
12	1	1	0	0	1	1	1	0
13	1	1	0	1	1	1	1	1
14	1	1	1	0	X	X	X	X
15	1	1	1	1	X	X	X	X

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Function Simplification:

For w: $w = \Sigma(12,13) \quad d = \Sigma(0,1,2,3,14,15)$

k-map:

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	X	X	X	X
$\bar{A}B$				
AB	1	1	X	X
$A\bar{B}$				

The simplified expression is, $w = AB$

For x: $x = \Sigma(8,9,10,11,12,13) \quad d = \Sigma(0,1,2,3,14,15)$

k-map:

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	X	X	X	X
$\bar{A}B$				
AB	1	1	X	X
$A\bar{B}$	1	1	1	1

The simplified expression is, $x = A$

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For y: $y = \Sigma(6,7,10,11,12,13)$ $d = \Sigma(0,1,2,3,14,15)$

k-map:

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	X	X	X	X
$\bar{A}B$			1	1
AB	1	1	X	X
$A\bar{B}$			1	1

The simplified expression is, $y = AB + C$

For z: $z = \Sigma(5,7,9,11,13)$ $d = \Sigma(0,1,2,3,14,15)$

k-map:

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	X	X	X	X
$\bar{A}B$		1	1	
AB		1	X	
$A\bar{B}$		1	1	

The simplified expression is, $z = D$

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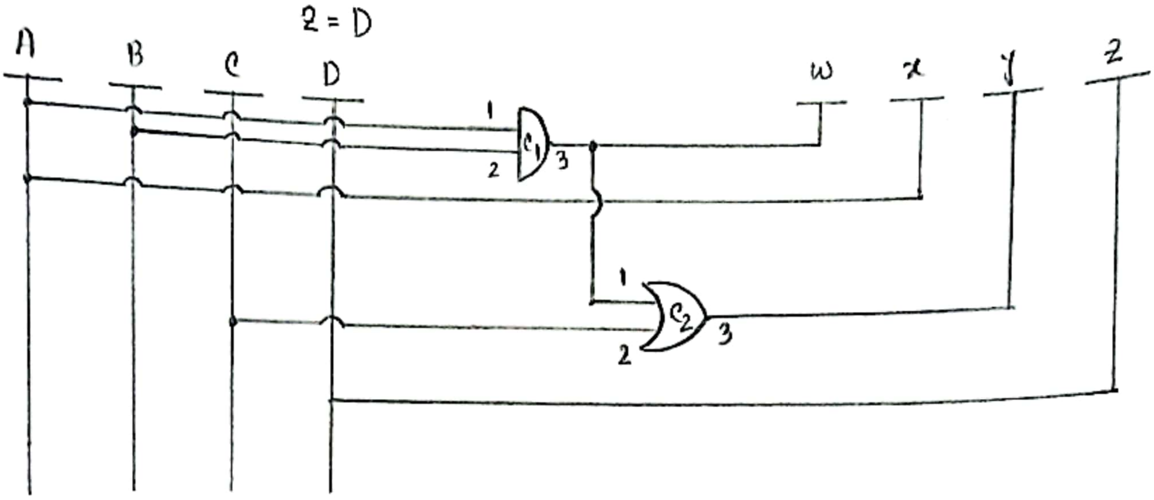
Circuit Diagram:

$W = AB$

$x = A$

$y = AB + C$

$z = D$



IC Requirements:

1. $C_1 \rightarrow$ 74LS08 (AND Gate) - 1 piece
2. $C_2 \rightarrow$ 74LS32 (OR Gate) - 1 piece

Conclusion: In this experiment, we have designed a combinational logic circuit to convert Excess-4 to 2421 code. With truth table and k-map we got the minimized expression and we implemented the expression with proper IC requirements.

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Experiment Name: Design a combinational logic circuit to convert the 5-bit BCD to Binary Equivalent

Objective: BCD is a class of binary encoding of decimal number. The binary number is a number express in the binary numerical system or base-2 numerical system which represents numeric values using two different symbols typically 0 and 1. The objective is to design a combinational logic Circuit to convert the 5 bit BCD to binary equivalent.

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Truth Table:

Decimal Value	Input (BCD)					Output (Binary)				
	A	B	C	D	E	F_5	F_4	F_3	F_2	F_1
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	0	1
2	0	0	0	1	0	0	0	0	1	0
3	0	0	0	1	1	0	0	0	1	1
4	0	0	1	0	0	0	0	1	0	0
5	0	0	1	0	1	0	0	1	0	1
6	0	0	1	1	0	0	0	1	1	0
7	0	0	1	1	1	0	1	1	1	1
8	0	1	0	0	0	0	1	0	0	0
9	0	1	0	0	1	0	1	0	0	1
10	0	1	0	1	0	X	X	X	X	X
11	0	1	0	1	1	X	X	X	X	X
12	0	1	1	0	0	X	X	X	X	X
13	0	1	1	0	1	X	X	X	X	X
14	0	1	1	1	0	X	X	X	X	X
15	0	1	1	1	1	X	X	X	X	X
16	1	0	0	0	0	0	1	0	1	0
17	1	0	0	0	1	0	1	0	1	1
18	1	0	0	1	0	0	1	1	0	0
19	1	0	0	1	1	0	1	1	0	1
20	1	0	1	0	0	0	1	1	1	0
21	1	0	1	0	1	0	1	1	1	1
22	1	0	1	1	0	1	0	0	0	0
23	1	0	1	1	1	1	0	0	0	1
24	1	1	0	0	0	1	0	0	1	0
25	1	1	0	0	1	1	0	0	1	1
26	1	1	0	1	0	X	X	X	X	X
27	1	1	0	1	1	X	X	X	X	X
28	1	1	1	0	0	X	X	X	X	X
29	1	1	1	0	1	X	X	X	X	X
30	1	1	1	1	0	X	X	X	X	X
31	1	1	1	1	1	X	X	X	X	X

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Function Simplification:

For $F_5 = \Sigma(22, 23, 24, 25)$ $\quad d = \Sigma(10, 11, 12, 13, 14, 15, 26, 27, 28, 29, 30, 31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$								
$\bar{A}B$			X	X	X	X	X	X
AB	1	1	X	X	X	X	X	X
$A\bar{B}$					1	1		

The simplified expression is $F_5 = AB + ACD = A(B + CD)$ [Distributive Law]

For $F_4 = \Sigma(8, 9, 16, 17, 18, 19, 20, 21)$ $\quad d = \Sigma(10, 11, 12, 13, 14, 15, 26, 27, 28, 29, 30, 31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$								
$\bar{A}B$	1	1	X	X	X	X	X	X
AB			X	X	X	X	X	X
$A\bar{B}$	1	1	1	1			1	1

The simplified expression is $F_4 = \bar{A}B + A\bar{B}\bar{C} + A\bar{B}\bar{D} = \bar{A}B + A\bar{B}(\bar{C} + \bar{D})$

For $F_3 : \Sigma(4, 5, 6, 7, 18, 19, 20, 21)$ $\quad d = \Sigma(10, 11, 12, 13, 14, 15, 26, 27, 28, 29, 30, 31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$					1	1	1	1
$\bar{A}B$			X	X	X	X	X	X
AB			X	X	X	X	X	X
$A\bar{B}$			1	1			1	1

The simplified expression is $F_3 = A\bar{C}D + \bar{A}C + C\bar{D}$

$= A\bar{C}D + C(\bar{A} + \bar{D})$ [Distributive Law]

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For F_2 : $F_2 = \Sigma(2,3,6,7,16,17,20,21,24,25)$ $d = \Sigma(10,11,12,13,14,15,26,27,28,29,30,31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$			1	1	1	1		
$\bar{A}B$			X	X	X	X		
AB	1	1	X	X	X	X	X	X
$A\bar{B}$	1	1					1	1

The simplified expression is, $F_2 = A\bar{D} + \bar{A}D = A \oplus D$

For F_1 : $F_1 = \Sigma(1,3,5,7,9,17,19,21,23,25)$

$d = \Sigma(10,11,12,13,14,15,26,27,28,29,30,31)$

AB \ CDE	$\bar{C}\bar{D}\bar{E}$	$\bar{C}\bar{D}E$	$\bar{C}DE$	$\bar{C}D\bar{E}$	$CD\bar{E}$	CDE	$C\bar{D}E$	$C\bar{D}\bar{E}$
$\bar{A}\bar{B}$		1	1			1	1	
$\bar{A}B$		1	X	X	X	X	X	X
AB		1	X	X	X	X	X	X
$A\bar{B}$		1	1			1	1	

The Simplified expression is $F_1 = E$

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Circuit Diagram:

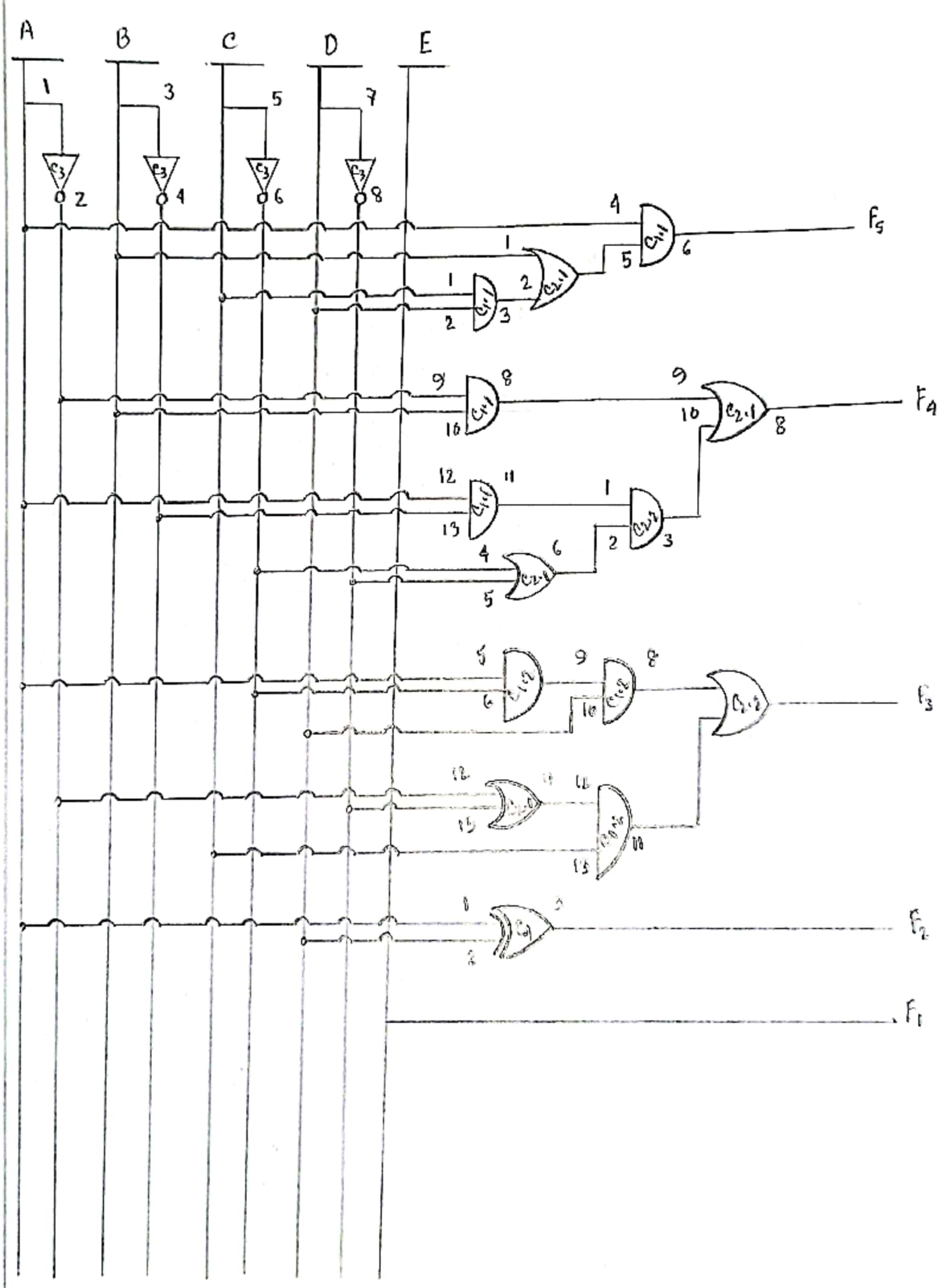
$F_5 = A(B + CD)$

$F_4 = \bar{A}B + A\bar{B}(\bar{C} + \bar{D})$

$F_3 = A\bar{C}D + C(\bar{A} + \bar{D})$

$F_2 = A \oplus D$

$F_1 = E$



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IC Requirements :

1) C_1 - 74LS08 (AND Gate) - 2 pieces

2) C_2 - 74LS32 (OR Gate) - 2 pieces

3) C_3 - 74LS04 (NOT Gate) - 1 piece

4) C_4 - 74LS86 (XOR Gate) - 1 piece

Conclusion: In the experiment, we have designed combinational logic circuit to convert 5 bit BCD to Binary Equivalent. Here 10 to 15 and 26 to 31 are don't care. We have implemented the circuit with proper IC connections.